Government Expenditures on Education, Fertility Rate, and Child Schooling

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Abstract

In many developing countries, a modern sector coexists with a traditional, informal, sector often intensive in child labor. In such a setting, when parents care about both the number and well-being of offspring, but also attach an economic value to children, there is a positive association between the number of offspring in the family and child's time allocated to schooling. As a result, government expenditures on education fail to enhance optimal growth of human capital.

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1 Introduction

When are government expenditures on education effective in raising the growth rate of human capital in a low-income country? It is a well-documented fact that to the extent that educational attainment is rewarded with higher future wages, how many years of schooling a child can complete has important long-term implications not only for the quality of children's own lives but also for the quality of the economywide labor force and thus economic development. In most low-income countries, however, the number of completed years of schooling for a child is on average very low (see Human Development report, United Nations, 1980-1997); and child labor force participation remains pervasive (Canagarajah and Coulombe, 1997). Whether in urban or in rural areas, children in most these countries continue to play an important role in the household economy as contributors to family income, which prevent them from remaining enrolled in school long enough to gain valuable education.

The common point of empirical studies focusing on the issue of Child work and schooling (e.g. Levison, 1993; Chernichovski, 1985; Levy, 1985; Rosenzweig and Evenson, 1977) is that the effect on fertility of the economic value of children is to be considered by low-income countries' public policy decision makers interested in raising the growth rate of human capital. Despite being well-documented, this point is yet to attract formal analysis. Theoretical works focusing on human capital and growth (e.g. Becker, Murphy, and Tamura 1992) have sidestepped the effect on fertility of the economic value parents may attach to children. Conclusions derived from such frameworks tend to advocate government intervention in education as the social accommodating policy. A notable example is Glomm (1997).

In Glomm (1997), a government finances publicly provided education with a proportional tax rate. If this tax rate is sufficiently high, the growth rate of the economy is higher with a public education regime than with a private education. In that environment, individual agents perceive the modern good and the traditional good as perfectly substitutable, and there is no (endogenous) population growth. While in such a setting child schooling imposes indirect costs to parents due to the economic value attached to children, these indirect costs, however, do not have a constraining effect on parental choice of child's human capital investment, since parents care only about the welfare of their offspring (but not their number), and there is perfect substitutability between the formal sector and the informal sector

goods. One may therefore ask, whether, relaxing these two assumptions (perfect substitutability and no population growth) has implications for the ability of public education to enhance optimal growth of human capital.

To address this question, the present paper develops a two-sector general equilibrium model with a endogenous fertility and growth. The setting is that of a low-income country in which altruistic parents make schooling decisions on behalf of their offspring, and attach an economic value to children. In addition, individual agents perceive the modern sector good and the traditional sector good as imperfect substitutes. This reflects the observed coexistence, in many low-income countries, of an informal sector specialized in the production of traditional goods (such as agricultural products), with a modern sector often specialized in the production of manufacturing goods—which may differ in characteristics from agricultural products. Altruism is expressed through parental preference for both quantity and quality of offspring. Even when parents have a preference bias towards quality of offspring, imperfect substitutability and material benefits provided by children cause child's time allocated to schooling and total fertility rate to be positively associated. As a result, growth of human capital may fail to materialize under a public education regime, since the negative externality on human capital accumulation is not internalized within the household. The remainder of this paper is structure as follows. Section 2 presents the model and concluding remarks in section 3 close the paper.

2 The Setting

Consider a dynastic population where individuals live for two periods, childhood and adulthood. All agents are identical within each generation t ($t = 0, 1, ...$). At date 0, there is an initial adult, the founder of the dynasty who designs a plan for the whole infinite horizon of her dynasty. The dynasty founder's objective is to choose a sequence of consumption, $\{c_t\}_{t=0,1,...}$, of a non-storable composite good, and a sequence, $\{N_{t+1}\}_{t=0,1,...}$, of future members of the dynasty so as to maximize total present discounted utility:

$$\sum_{t=0}^{\infty} \rho^t N_t^{\xi} \left(\frac{c_t^{1-\sigma}}{1-\sigma} \right), \tag{1}$$

where ρ ($0 < \rho < 1$) is a subjective discounting factor, σ ($0 < \sigma < 1$) is the inverse of the constant intertemporal elasticity of substitution, and

ξ $(0 < \xi \leq 1)$ is an altruism parameter implying a constant elasticity of parental altruism per child as the number of children increases. Since $0 < \xi$, parental altruism is reflected by preferences for quantity as well as quality of offspring. There is preference bias towards quality if $\xi < 1 - \sigma$; the bias goes in the opposite direction if $\xi > 1 - \sigma$.

At each period, all agents (children and adults) are endowed with one unit of non-leisure time. A typical adult (born at $t-1$) allocates his non-leisure time between two activities, child-rearing (ϑ), and work $(1-\vartheta)$. If a generation t adult allocates a fraction ϑ_t of his non-leisure time to child-rearing, population will evolve over time according to a linear low of motion,

$$N_{t+1} = \vartheta_t N_t. \tag{2}$$

In this environment, a typical child makes no time allocation decisions; these decisions are made by his altruistic (single) parent. A child's non-leisure time is allocated between two activities, school attendance (s) and work $(1-s)$. Education is provided by the government free of (direct) charge. Government education expenditures are financed by taxes collected from all adult workers according to a uniform tax rate, τ. If a child born in period t attends a (public) school with education quality, $\widetilde{E}_t$, for a period of length s_t (determined by his altruistic parent), his accumulated human capital is:

$$h_{t+1} = s_t \widetilde{E}_t^{\delta} \bar{h}_t^{1-\delta}, \tag{3}$$

where $0 < \delta < 1$, $\bar{h}_t$ is the date t average human capital level of adult agents,

$$\widetilde{E}_t = \frac{E_t}{N_{t+1}}, \tag{4}$$

E_t is total government expenditure on education, and N_{t+1} is the number of children born of generation t parents. The structure of this human capital accumulation technology reflects the view that in low-income countries, publicly provided education inputs are determinant for human capital development. It also implies that public education is subject to congestion, where the congestion effect is measured by equation (4). The issue at stake is whether this congestion effect is properly internalized within the household when parents who care about both the quantity and quality of offspring make time allocation decisions on behalf of their offspring and perceive the modern and the traditional good as imperfectly substitutable goods.

To emphasize the distinguishing feature of imperfect substitutability between the modern good (x), and the traditional good (z), own consumption of the composite good is described by

$$c_t = x_t^{\alpha} z_t^{1-\alpha}, \tag{5}$$

where α ($0 < \alpha < 1$) and $1 - \alpha$ are relative (utility) weights a typical adult attaches to the consumption of the modern good and the traditional good. Since a child investment in human capital only yields returns the next period, children in this environment can only work in the traditional good sector which uses exclusively raw labor, as in Glomm (1997).

All private agents in this environment take prices as given. Letting the modern good be the *numéraire,* the effective dynastic budget constraint is:

$$N_t \left[x_t + p_t z_t\right] \leq \omega_{xt}(1-\tau)(1-\vartheta_t)h_t N_t + \omega_{zt}(1-s_t)N_{t+1}, \tag{6}$$

where p_t is the date t market price for the traditional good in terms of the modern good, and ω_{lt} is the date t wage rate for sector l ($l = x, z$). The dynasty head problem is to maximize (1) subject to constraints (2), (3), (5), and (6), given h_0. The first order conditions for an interior solution to this problem are summarized in the Appendix section.

The modern good sector output is produced by competitive firms using effective human capital (H) according to a constant returns to scale technology, $Y_{xt} = H_t$. Profit maximization in this sector therefore implies that $\omega_{xt} = 1$. Production of the traditional good does not use human capital; instead, it is carried out through informal modes of production using child raw labor only; it is described by $Y_{zt} = L_t$, where L_t is effective child labor. Profit maximization in this sector implies that $\omega_{zt} = p_t$.

The economywide resource constraints are given by:

$$N_t x_t + E_t \leq Y_{xt}; \tag{7}$$

$$N_t z_t \leq Y_{zt} \tag{8}$$

$$H_t \leq N_t h_t (1-\vartheta_t); \tag{9}$$

$$L_t \leq (1-s_t)N_{t+1} \tag{10}$$

If government budget is balanced, total education expenditure in each period is

$$E_t = \tau \omega_{xt}(1-\vartheta_t)h_t N_t. \tag{11}$$

Given the initial h_0, a *competitive equilibrium* for this economy is a collection of allocation sequences $\{c_t, s_t, \vartheta_t, x_t, z_t, h_{t+1}, N_{t+1}, H_t, L_t\}_{t=0,1,...}$, a collection of price sequences $\{p_t, \omega_{xt}, \omega_{zt}\}_{t=0,1,...}$, and laws of motion for population and human capital, such that,

(i) (*Dynasty Head problem):* given p_t, the allocation $(c_t, s_t, \vartheta_t, x_t, z_t, h_{t+1}, N_{t+1})$ solves the dynasty head's problem; and, in each period

$$\bar{h}_t = h_t; \tag{12}$$

(ii) (*Modern good sector*): given (p_t, ω_{xt}), H_t satisfies profit maximizing condition;

(iii) (*Traditional good sector*): given ω_{zt}, L_t satisfies profit maximizing condition;

(iv) all markets clear, i.e., (7)-(10) are satisfied with equality.

Along the *balanced growth* path— the path along which population growth rate and human capital growth rate are constant— time allocations and the relative (gross) return to child labor, p_t/h_t, will be constant (i.e., $s_{t+1} = s_t$, $\vartheta_{t+1} = \vartheta_t$, $h_{t+1}/p_{t+1} = h_t/p_t$, all t). The main task in this paper is to characterize the association between total fertility rate and child completed years of schooling (here proxied by child's time allocated to schooling) and to determine how this association affects the rate of growth of human capital in the economy. This task is carried below.

The first order conditions for the dynastic founder's problem (see appendix for details) leads to

$$\gamma\left[1-\beta\varphi(\vartheta)\right] - \left[1-\gamma\varphi(\vartheta)\right]\phi(s) = 0, \tag{13}$$

at least for some $(s, \vartheta) \in (0,1)\times(0,1)$, where $\gamma = (1-\alpha)/\alpha$,

$$\beta = (1/\alpha)\left[1-\alpha-\xi/(1-\sigma)\right],$$

$\varphi(\vartheta) = (1-\vartheta)/\vartheta$, and s et ϑ denote steady state child's time allocated to schooling and total (gross) fertility rate respectively. For simplicity, assume

$\beta = 0$, i.e., $\xi/(1-\sigma) = 1-\alpha$. Since $0 < \alpha < 1$, this latter assumption implies that parents in this environment have a preference bias towards the quality of offspring. Note also that for $\vartheta > 1-\alpha$, $1-\gamma\varphi(\vartheta) > 0$. In particular, for all $\vartheta \in (\bar{\vartheta}, 1)$, where $\bar{\vartheta} = 1-\alpha$, equation (13) leads to a characterization of the association between child's time allocated to schooling, $s \in (0,1)$, and total (gross) fertility rate, ϑ, as follows:

$$s = \frac{1-\gamma\varphi(\vartheta)}{1-\gamma\varphi(\vartheta)+\gamma}. \tag{14}$$

Since by definition, $\varphi'(\vartheta) < 0$, the equality in (14) implies that, when the traditional good and the modern good are imperfectly substitutable, and parents attach an economic value to children, the number of offspring in the household and child's time allocated to schooling are positively associated, even when parents have a preference bias towards quality of offspring (i.e., $\xi < 1-\sigma$). The positive association derived in this paper can be justified as follows. On the one hand, a rise in the tax rate, *ceteris paribus*, raises the quality of education provided by the government. This, in turn, raises the benefits of child's education, causing parents (who care about the welfare of their offspring) to augment child's time allocated to schooling, s. On the other hand, since a rise in child's time allocated to schooling causes a decline in the effective supply of child raw labor, the wage rate, $w_{zt} = p_t$ will rise, thus raising the relative (net) return to child labor, $p_t/(1-\tau)h_t$. As a result, it becomes more beneficial to parents to raise their fertility rate, ϑ, so as to increase the number children in the household and thus the total contribution of children to family income.

The above result is consistent with empirical findings by Chernichovsky (1985) and Levy (1985). Chernichovski (1985) uses data from Botswana to reject the hypothesis that there is a trade-off between child's time allocated to schooling and the number of children in the household. Levy (1985), on his part, examines cross-sectional evidence on differential fertility in rural Egypt, focusing on the relation between structural policy changes in agriculture, on the one hand, and fertility and children's schooling, on the other. His results indicate, among other interesting points, that cotton production's intensity in child raw labor is one of the basic conditions motivating Egyptians farmers to have relatively large families.

Implications for the growth rate of human capital

The positive association between child's time allocated to schooling and fertility rate implies that parents in this environment are unable to substitute quality for quantity offspring. The growth effect of this positive association are characterized as follows. From the law of motion of human capital, substituting in, equilibrium conditions using (2) yields (gross) growth rate of human capital

$$\frac{h_{t+1}}{h_t} = s\left[\tau\varphi(\vartheta)\right]^{\delta}.$$

Since s and ϑ are positively associated, any policy that induces parents to increase s (example improvements in the quality of public education, through increased taxes), also leads them to increase ϑ. Consequently, the congestion effect is not internalized, since $\varphi'(\vartheta) < 0$, for all $\vartheta \in (0,1)$, implying that a public education regime fails to produce an optimal growth rate for human capital. This result is at odd with Glomm's (1997) findings.

3 Concluding Remarks

This paper uses a dynastic population model with endogenous fertility and growth, to study the effect of government education spending on the growth rate of human capital. The setting is that of a low-income country in which altruistic parents make schooling decisions on behalf of their offspring, and attach an economic value to children. In addition, individual agents perceive the modern sector good and the traditional sector good as imperfect substitutes. This reflects the observed coexistence, in many low-income countries, of an informal sector specialized in the production of traditional goods (such as agricultural products), with a modern sector often specialized in the production of manufacturing goods. The paper's main finding is that even when parents have a preference bias towards quality of offspring, imperfect substitutability and material benefits provided by children cause child's time allocated to schooling and total fertility rate to be positively associated. As a result, growth of human capital may fail to materialize under a public education regime, since the negative externality on human capital accumulation is not internalized within the household. Therefore, in order for government spending on education to be effective in raising the growth rate of human capital, this policy may need to be supplemented by measures aiming at altering the very structure of developing countries economies. In particular, a pattern of modernization that emphasizes advances in the production

processes of traditional goods (e.g. mechanization of agriculture) may need to be encouraged. One effect of such a pattern of modernization would be to eliminate or at least substantially reduce the economic value parents attach to children. Empirical support for this recommendation can be found in Levy (1985).

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Appendix.

The first order conditions for an interior solution to this problem can be summarized as follows:

$$c_t \quad : \quad \rho^t N_t^{\xi} c_t^{-\sigma} - \lambda_{ct} = 0, \tag{15}$$

$$x_t \quad : \quad \alpha\lambda_{ct} c_t - \lambda_t x_t N_t = 0, \tag{16}$$

$$z_t \quad : \quad (1-\alpha)\lambda_{ct} c_t - \lambda_t p_t z_t N_t = 0, \tag{17}$$

$$\vartheta_t \quad : \quad \lambda_{N_t}\vartheta_t^{-1} N_{t+1} - \lambda_t(1-\tau)\omega_{xt} h_t N_t = 0, \tag{18}$$

$$s_t \quad : \quad \lambda_{h_t} s_t^{-1} h_{t+1} - \lambda_t \omega_{zt} N_{t+1} = 0, \tag{19}$$

$$\begin{aligned} N_{t+1} \quad : \quad & (\xi/1-\sigma)\rho^{t+1} N_{t+1}^{\xi-1} c_{t+1}^{1-\sigma} + \\ & \lambda_t(1-s_t)\omega_{zt} + \lambda_{N_{t+1}} N_{t+1}^{-1} N_{t+2} - \lambda_{N_t} \\ & +\lambda_{t+1}\left[\omega_{xt+1}(1-\tau)(1-\vartheta_{t+1})h_{t+1} - x_{t+1} - p_{t+1} z_{t+1}\right] = 0, \end{aligned} \tag{20}$$

$$h_{t+1} \quad : \quad \lambda_{t+1}\omega_{xt+1}(1-\tau)(1-\vartheta_{t+1})N_{t+1} - \lambda_{h_t} = 0, \tag{21}$$

plus appropriate transversality conditions, where λ_{ct}, λ_t, λ_{N_t}, and λ_{h_t} are multipliers associated with constraints (5), (2), (3), and (6), respectively.

From equation (16), dividing through by equation (17) and rearranging terms leads to

$$z_t = \frac{1-\alpha}{\alpha}\frac{x_t}{p_t}. \tag{22}$$

Likewise, combining equations (18) and (19), and rearranging terms using equilibrium conditions leads to

$$\frac{\lambda_{h_t} h_{t+1}}{\lambda_{N_t} N_{t+1}} = \frac{p_t s_t N_{t+1}}{(1-\tau)\vartheta_t h_t N_t}. \tag{23}$$

Along the *balanced growth* path, time allocations and the ratio $h_t \,/\, p_t$ will be constant (i.e., $s_{t+1} = s_t$, $\vartheta_{t+1} = \vartheta_t$, $h_{t+1}/p_{t+1} = h_t/p_t$, all t). This implies that

$$\frac{\lambda_{h_t} h_{t+1}}{\lambda_{N_t} N_{t+1}} = \frac{\lambda_{h_{t+1}} h_{t+2}}{\lambda_{N_{t+1}} N_{t+2}}. \tag{24}$$

Further, from equation (20), rearranging terms using equations (15), (16), (18), (22), and market clearing conditions leads to

$$\frac{\lambda_{N_t} N_{t+1}}{\lambda_{N_{t+1}} N_{t+2}} = \frac{1-\beta\varphi(\vartheta)}{1-\Omega(1-s)}, \tag{25}$$

where

$$\Omega = p_t/(1-\tau)h_t \tag{26}$$

is the ratio between the (net) rate of return to child labor (p_t) and the net rate of return to parental labor ($[1-\tau]h_t$). Throughout the rest of this paper, Ω is interpreted as the relative rate of return to child labor, as perceived by parents. The structure of Ω implies that higher (respectively, lower) taxes tend to increase (respectively, decrease) the economic value of child labor force participation.

Getting back to the first order conditions for the dynasty head problem, from equation (21), using equilibrium conditions as well as equation (19), and rearranging terms leads to

$$\frac{\lambda_{h_t} h_{t+1}}{\lambda_{h_{t+1}} h_{t+2}} = (s\Omega)^{-1}\varphi(\vartheta), \tag{27}$$

where s represents the steady state allocation of a child school attendance time. Equation (24) implies that the right-hand sides of (25) and (27) are equal. I.e.,

$$\frac{1-\beta\varphi(\vartheta)}{1-\Omega(1-s)} = (s\Omega)^{-1}\varphi(\vartheta) \tag{28}$$

for all $(\vartheta, s) \in (0,1) \times (0,1)$.

Now, using the market clearing condition for both the traditional good sector and the modern good sector, and combining them using equations (11) and (22) leads to

$$\Omega = \left(\frac{1-\alpha}{\alpha}\right)\frac{\varphi(\vartheta)}{1-s}, \tag{29}$$

where α denotes the utility weight of the modern good relative to the traditional good. Substituting back into (28), and rearranging terms yields expression (13).